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Georg J. Ziegltrum

Washington Forest Protection Association

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Commentary

Impacts of the black bear supplemental feeding program on ecology in western Washington

GEORG J. ZIEGLTRUM, Washington Forest Protection Association, 724 Columbia Street NW, Suite 250, Olympia, WA 98501, USA gziegltrum@wfpa.org

BLACK BEARS (*Ursus americanus*) are opportunistic omnivores (Simpson 1945) that feed on grasses, grubs, insects, berries, human garbage, and they scavenge from animal carcasses (Cotton 2008, Thiemann et al. 2008). During the spring, they also girdle trees to feed on the newly forming phloem (Poelker and Hartwell 1973, Noble and Meslow 1998, Partridge et al. 2001). Extensive black bear damage to conifers coincided with the beginning of intensive forest management on industrial and smaller private lands in western Washington during the early 1940s; high-yield tree plantations (i.e., tree farms) required protection to reduce tree girdling by black bears. During the mid-1950s, bear damage occurrence and frequency was recorded on Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*) after bear damage had spread across most of the Pacific Northwest (Lauckhart 1955).

Damage from bears girdling within a stand of trees can be extensive; a single foraging bear may peel bark from as many as 70 trees per day (Schmidt and Gourley 1992). Tree damage can be detrimental to the health of timber stands, reducing their economic value by millions of dollars annually in Washington (Nolte and Dykzeul 2002). Trees completely girdled during the spring appear red as their vigor declines and their needles become discolored. Partially girdled trees are physiologically stressed, and their needles will appear light green to yellow (Ziegltrum 1994). Dead trees appear gray because they have lost most of their needles. Because of this, areas containing bear-damaged trees can be mapped from the air and are later verified by ground truthing. Ground surveys usually detect 3 to 4 times more damaged trees

than are originally detected from the air. Bears leave stripped bark on the ground around the base of the tree, and vertical tooth and claw marks are generally visible on the bole (Figure 1). Mountain beavers (*Aplodontia rufa*) and porcupines (*Erethizon dorsatum*) may also girdle the bole near the ground of similar-age trees, though damage inflicted by these species is easily distinguishable from bear damage (Nolte and Otto 1995).

Complete girdling is lethal to trees, while partial girdling provides avenues for subsequent insect and disease infestation (Kanaskie et al. 1990). The severity of timber loss is compounded because bears select the most vigorous trees within the most productive stands, usually where stand improvements, such as thinning and fertilization, have been implemented (Mason and Adams 1989, Nelson 1989, Kanaskie et al. 1990, Schmidt and Gourley 1992, Kimball et al. 1998). Preference of bears for a particular tree or tree species may change with the phenological stage of the tree (Nolte et al. 1998). For example, hemlocks are generally



Figure 1: Typical black bear damage on a Douglas fir, background. (Photo courtesy Washington Forest Protection Association)

damaged earlier in the spring than are Douglas firs because of an earlier bud burst. Damage declines during late June as berries and other alternative foods become more readily available (Ziegltrum and Nolte 1995).

Supplemental bear feeding begins

The Washington Forest Protection Association (WFPA), an umbrella organization of the forest products industry in Washington State, confronted tree-girdling by bears in 1959, and the Animal Damage Control Service (ADCS) was organized in 1960 (Ziegltrum 1998). The ADCS did basic field work, such as damage surveys, hunting with hounds, and snaring, but had no research responsibility. This was a cooperative program between the Washington State Department of Natural Resources (DNR) and private forest land managers. It was intended to minimize black bear damage by depressing bear populations in areas of heavy tree damage. The damage control program was initially tolerated by the public, but in the early 1980s increased awareness resulted in greater criticism of killing bears for the benefit of growing trees (Flowers 1986). Consequently, the WFPA proposed the black bear supplemental feeding program during spring as a nonlethal bear damage control strategy. R. H. Flowers of the WFPA started producing feed pellets in his own mill in Aberdeen, Washington. The challenge was to find a pelletized food that was more palatable to bears than sapwood but less palatable than berries. The original pellet was composed of a mixture of meat meal, bone meal, molasses (39%), and a mash of ground sugar beet pulp, cane sugar, salt, magnesium sulfate, anis feed aroma, and swine vitamin minerals (61%). The mixture was then tested for 3 months on 2 captive bears in Olympia, Washington. It was later field tested at a 40-ha unit near Kalaloch, Washington (Flowers 1986).

The ADCS was renamed Animal Damage Control Program (ADCP) because the responsibilities of the program supervisor now included the coordination of research among stakeholders, in addition to field work. The ADCP planned to feed free-ranging bears for only 2–3 months during the spring, before wild berries became ripe. In early July, bears needed to wean off the pellets naturally. Initial feeding results during 1985 were impressive

because bear damage was reduced and ceased altogether in some stands. Tests continued for 2 more years with similar results.

In 1990, spring supplemental black bear feeding as a damage control tool on large areas of industrial forest lands began in western Washington. At the time, the Washington State Department of Fish and Wildlife (WDFW) estimated the black bear population in Washington to be 25,000–50,000 animals (Tirhi 1996), and it was obvious that supplemental feeding needed to be concentrated at timber stands with severe damage or it would become too expensive and unmanageable. During the same year, the Weyerhaeuser Snoqualmie Tree Farm in western Washington used the black bear supplemental feeding program in an 18-year-old, pre-commercially thinned Douglas fir stand with a 2-year history of black bear damage. Five feeding stations were installed from April 20 to June 30 and stocked with 2,270 kg of pellets (Figure 2). Beaver carcasses were hung from nearby trees initially to attract the bears to the feeding sites. Surveys in August 1988 showed no additional trees damaged during the spring throughout the unit (Flowers 1988).

Over the next 7 years, the ADCP expanded its bear feeding operations in western Washington to most bear-damage sites and each year doubled the total amount of feed distributed to bears. In 1995, the ADCP was feeding about 3,000 black bears. This estimate was based on bear tracks in front of feeding stations, the amount of pellets eaten per week, the total amount of pellets consumed during the spring,



Figure 2: A black bear approaches a spring feeding station in western Washington. Each feeding station holds up to 125 kg of pellets. (Photo courtesy Washington Forest Protection Association)

and a feeding period of 70 days. A feeding station held 125 kg of pellets and was stocked weekly. We determined the amount of pellets bears ate each week by weighing the pellets that we added to refill the feeding stations. We concluded that 1 bear ate 0.5–1.5 kg of pellets daily. In 1996, a threshold was reached with 850–900 feeding stations and approximately 225,000 kg of pellets distributed annually. The feeding program was protecting about 400,000 ha of pre-commercially thinned 15–25-year-old Douglas fir stands (Adams 1992, Mitchell 2001, Ziegler 2004).

Concern about the bear-feeding program success

The population density of bears at newly-established feeding stations increased each year, and, in 1994, foresters began to fear a potential loss of the efficacy of the feeding program (Ziegler 1994). Land managers asked if intensive use of the supplemental feeding program could create more bears with higher reproductive success, particularly in areas where low bear densities were desired. In 1997, the ADCP received permission from the WFPA's executive committee and the WDFW to investigate this concern, and field work began in March 1998. The ADCP trapped and radio-collared 17 bears in feeding areas between Rochester and Oakville, Washington, and 8 bears in non-feed areas in the Capitol Forest. The bears were immobilized with Telazol (5.0–7.0 ml/kg), administered using Palmer Cap-Chur dart guns (Fort Dodge Laboratories, Fort Dodge, Ia.). The reproductive success of bears that used feeding stations was monitored and compared with the reproductive success of bears without access to feeding stations. The telemetry data, supported by the video monitoring of marked bears, showed a higher concentration of bears around areas with feeding stations only during the spring. The bear concentration increased annually because bear sows brought their cubs to the feeding stations and not because bears were drawn in from non-feed areas. We observed that, after 2-year-old bears were weaned off their mothers, they continued visiting feeding stations. One yearling male visited a feeding station with its mother in early spring and came alone in June, having remembered locations of feeding

stations within its range. In June, its mother visited multiple feeding stations with different males accompanying her. She brought her new cubs to the feeding stations 1 year later. During the spring of 1999, we found no difference in cub production after bears emerged from their winter dens in March of the next year.

Foresters also were concerned about the safety of their feeding personnel because 90% of injuries by bears to people were inflicted by bears that were conditioned to associate humans with food (Herrero et al. 1998). Hence personnel were encouraged to carry firearms for personal protection.

In interviews I conducted, ADCP feeding personnel repeatedly reported sightings of bears at established feeding locations. Typical bear behavior was to avoid contact with humans despite the connection they obviously made between feeding personnel and food in feeding stations. Bears walked away from feeding stations when feeding personnel approached, but they waited close by. When feeding personnel left the feeding stations, bears walked back to the feeders within minutes and continued to feed on the pellets. The ADCP has no reports of any bear-human conflicts, human injuries, or any aggressive bear incidents during 20 years of stocking black bear feeding stations.

Impacts of the feeding program on bears

Impacts on bear behavior

Land managers raised concerns about undesired impacts of extended supplemental feeding of black bears. In 1996, foresters became concerned that dominant male bears prevented other bears from accessing the feeding stations. In the spring of 1998 and 1999, Nolte et al. (2000) tested this hypothesis. They captured 17 bears, using Aldridge foot snares, and the ADCP team earmarked or radio-collared the bears for identification later. In April 1999, 4 areas with established feeding stations about 5 km apart from each other were selected. Four platforms were built about 4 m above the ground around a tree in each area. The platforms were about 10 m away from the feeding stations and mounted with 1 Panasonic video camera, a Pelco motion detector, and a Panasonic time-lapse recorder

and television system. Marine batteries powered the equipment. Bear behavior and interactions around feeding stations were videotaped from May 1 to July 10, 1999. Bears approaching the feeding stations triggered the motion sensor mechanism, and the cameras videotaped the bears' activities.

Twenty bears, including the seventeen that were ear-marked, visited the videotaped feeding stations. Female bears with and without cubs or yearlings, as well as males of all age classes came to the feeders but fed at different times. Only one bear sow was accompanied by an adult male during mating season in June and shared the feeding station. Most bears visited at least 2 feeding stations, and several were videotaped at all 4 feeding stations. Bears showed up at feeders every 2–3 days and stayed for 15 minutes or less. Mean feeding time (i.e., amount of time bears had their heads in the feeding stations) was only 1.5 minutes. Bears fed at feeding stations throughout the day but preferred the early morning, late afternoon, and the evening hours. Lactating females were very alert around feeding stations and kept the cubs close. Adult male bears showed little concerns while feeding on pellets. All bears had equal access to the feeding stations throughout the 2.5 months of observations. They seemed to have learned that feeding stations provided an unlimited source of food and, therefore, showed very little antagonistic behavior. The study concluded that adult male bears did not dominate feeding stations. Black bears did not become dependant on the supplemental feeding program throughout the year.

Fersterer et al. (2001) investigated impacts of supplemental bear feeding on bears' movement patterns, documenting home range sizes for male and female bears. In 1999, 25 bears, of which seventeen fed regularly at the feeding stations around Oakville and Rochester and eight with no access to feeding stations in the Capitol Forest, were radio-collared. Movements were monitored from May 1 to June 30, when bears used the supplemental feeding stations, and later, between the end of July and beginning of October, before winter denning. The well-designed road system enhanced the efforts to locate bears from a car by telemetry triangulation. Bear locations were repeatedly identified by triangulating telemetry points

until the error ellipse of all points was smaller than an area 35 m². A 3-factor analysis of variance was used to compare home range size differences among (1) bears with and without access to feeding stations, (2) males or females, and (3) periods of telemetry triangulation (during feeding at feeding stations or after bears weaned off the feeding stations). The home range and size were then established using the minimum polygon method with a 5% reduction of the area (Kenward 1987).

The study concluded that male bears generally had larger home range sizes than did females, but this difference was consistent across feeding and non-feeding areas. The home range size among bears in feeding areas did not differ ($P > 0.35$). Bear densities around feeding stations increased only during the spring feeding period, and home ranges were therefore temporarily smaller in comparison to those of bears without access to pellets.

Impacts on bear nutrition

Robbins et al. (2004) studied the nutritional ecology of bears and summarized the supplemental black bear feeding program as a tool that successfully reduced conifer damage in the Pacific Northwest. Foresters in western Washington came to the same conclusion, based on field observations, and they wanted to know how the bear-feeding program influenced the bears' nutrition. They argued that well-fed bears may reproduce more successfully than non-fed bears. To determine this, Partridge et al. (2001) researched dietary needs and weight gain of bears that frequented feeding stations. Partridge used Aldrich foot snares to trap bears (22 female and 31 male) 68 times during April and May 1998–2000 before bears started accessing the feeding stations. In non-feeding areas, 11 female and 12 male bears were snared in 28 captures during the same time period. Partridge immobilized, ear-tagged, and injected the bears subcutaneously above the neck with a passive integrated transporter (PIT tag; Avid Power Tracker II Multi Mode Reader, Norco, Calif.). Partridge radio-collared the bears with standard VHF equipment (Advanced Telemetry Systems, Isanti, Minn.), weighed them, and extracted 1 tooth to age the animals. Blood samples were taken to analyze the diet of the bears through isotopic analysis in the laboratory (Hildebrand

et al. 1996). Scat analysis verified the species of plant material that bears ingested (Partridge et al. 2001). All bears recaptured in areas with feeding stations consumed food pellets but also fed on grasses, forbs, and invertebrates. Partridge estimated that sapwood comprised 3% of their diet. Pellet-fed bears gained more body mass during the supplemental feeding period than did the bears without access to the pellets. However, non-fed bears compensated for short-term weight differences in spring by increased berry foraging during summer and fall of the same year. Bears in the non-feed areas gained weight 3–4 times faster during the rest of the year than bears feeding on pellets in spring (Welch et al. 1997, Partridge et al. 2001). Body compositions of bears in both feeding and non-feeding areas (28% fat and 72% lean body mass) were similar and were characteristic of bears in other areas. Thus body composition was not influenced by pellet consumption (Hildebrand et al. 1999, Partridge et al. 2001). Bears with access to pellets had roughly the same body weight when entering their winter dens in late November as bears without access to pellets. Winter survival was not different among fed and non-fed bears.

Conclusion

The black bear supplemental feeding program successfully deterred bears from damaging trees. In addition to Washington State and Oregon, ADCP pellets were used since 2003 in Asia, Prefecture of Gunma, and Japan (B. Kamiyama, Kiryu, Japan, personal communication). Forest managers in Croatia, Europe, produced their own pellets, using the ADCP formula, since 2002 (D. Huber, University of Zagreb, Croatia, personal communication). Supplemental feeding also stimulated an international discussion about the pros and cons of the program and the implications for forest management.

All age classes and gender of bears, including female bears with cubs, fed on the pellets. Although large bears did not dominate feeding stations, they did mark and destroy some trees to attract females during the mating season in early summer. This behavior was not an economic problem and did not trigger control action. The supplemental feeding program

had no influence on the home ranges of bears throughout the year, but it did during a 2.5-month period in the spring when supplemental food was provided. The ADCP had no reports of conflicts between bears and feeding personnel. The reproductive success among fed and non-fed bears was similar.

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GEORG J. ZIEGLTRUM is the animal damage control supervisor for the Washington Forest Protection Association in Olympia, Washington, a position he has held since 1989. He received a masters degree in forest and wildlife ecology from the Georg-August University in Goettingen, Germany, and is finishing a dissertation on forest science at the Technical University, in Munich, Germany. His research and publications concentrate on minimizing spring black bear damage to conifers in western Washington and the effectiveness, economy, and ecology of nonlethal damage control tools, such as supplemental feeding programs. In coordination with the Washington State Department of Fish and Wildlife, he manages all lethal damage control operations, such as hound hunts, snaring, trapping, and boot hunts during the spring.